

# **THE DEMAND FOR BANDWIDTH: SECOND TELEPHONE LINES AND ON-LINE SERVICES**

James Eisner and Tracy Waldon\*  
Common Carrier Bureau, Industry Analysis Division  
Federal Communications Commission  
Washington, DC 20554

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Since 1992, additional residential lines have been increasing at 18% per year. These phone lines have been the major source of growth in the residential phone market over the past several years. For example, in 1995, 83% of the net growth in residential access lines was due to the installation of additional lines in homes. The trend in purchasing additional phone lines has occurred during the same time that subscriptions to on-line service providers, such as CompuServe, America On-Line (AOL), and independent internet service providers, have grown at a phenomenal rate of nearly 50% per year.

These trends have not escaped the notice of local exchange carriers. Reports to shareholders routinely emphasize the role of additional phone lines in residential revenue growth. In addition, in some states carriers are offering reduced installation fees and advice on the installation of inside wiring for additional residential lines.

The downside of the increased residential use of the telephone network for accessing on-line services has also not escaped notice. Local exchange carriers have petitioned the Federal Communications Commission (FCC) to allow them to charge internet service providers additional fees for accessing the local network.<sup>1</sup> Carriers cite the increased loads on local switches due to the long call lengths associated with connections to on-line service providers to justify the need for additional charges.

In this paper, we examine the factors affecting the decision to purchase an additional telephone line. In addition, we explicitly model the choice to subscribe to an on-line service and that decision's influence on the purchase of a second line. Section I introduces the data and presents the econometric specification of the model. Section II presents the results of the estimation and examines the influences of some of the variables on the decision to purchase an additional phone line and subscribe to an on-line service. Section III examines some implications

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<sup>1</sup> *Notice of Inquiry on Implications of Information Service and internet Usage*, CC Docket No. 96-262, FCC No. 96-488, released December 24, 1996.

of our results on the demand for broadband services and the impact on future competitors in the local exchange market.

## I. The Data and Econometric Specification

The primary data source used in this research is PNR and Associates (PNR) Bill Harvesting II database. PNR is an economic research, market application and consulting firm located in Jenkinstown, PA. Bill Harvesting II is a survey that collected data on telephone usage, second lines, on-line service and demographic characteristics of United States households in 1995. Sample households have sent copies of their telephone bills to PNR and have answered a series of survey questions.

The sample used in this research consists of 7,664 households that had telephone service provided by one of the seven Regional Bell Operating Companies (RBOCs), Cincinnati Bell or Southern New England Telephone Company (SNET). Households with other local exchange carriers are excluded from our sample since the authors do not have information on monthly telephone rates, connection fees and service availability for other carriers.

The decision to subscribe to a second line and to subscribe to an on-line service is modeled using a bivariate probit model. This specification takes into account that subscribing to a second line and to an on-line service may be a joint decision. Following Maddala's (1983) framework of a bivariate probit model, the empirical model of the decision to purchase a second phone line ( $y_1 = 1$ ) and subscribe to an on-line service ( $y_2 = 1$ ) can be described by:

$$y_1 = 1 \text{ when } y_1^* > 0$$

$$y_1 = 0 \text{ when } y_1^* < 0$$

and

$$y_2 = 1 \text{ when } y_2^* > 0$$

$$y_2 = 0 \text{ when } y_2^* < 0$$

$$\text{where } y_1^* = \alpha_1 + \beta_1 \cdot X_1 + \psi_1 \cdot y_2 + \epsilon_1$$

$$y_2^* = \alpha_2 + \beta_2 \cdot X_2 + \epsilon_2$$

$$(\epsilon_1, \epsilon_2) \sim N(0, \Sigma)$$

Subscribing to a second line is modeled as a function of subscribing to an on-line service and a vector of independent variables ( $X_1$ ) that include the price of the second line and the regulatory structure, residing in a metropolitan statistical area (MSA), household income, occupation variables and demographic characteristics. The *Reference Book of Rates, Price Indices and Household Expenditures for Telephone Service* (FCC, 1997) and *NARUC* (1996a) provide data on monthly rates and connection charges for telephone service. A households monthly rate is estimated by using a simple average of the household's local exchange carrier rate in each city reported in these sources from the state in which the household resides. The rate for unlimited local telephone service represents the monthly rate of a second line.<sup>2</sup> The connection fee is included since the overall cost of a second line includes the one-time connection fee. A variable that indicates whether a household's local exchange carrier is covered by price cap regulation at the state level is also included. Carriers that are covered by price cap regulation, as compared to rate of return regulation, may have more flexibility in setting prices. The type of local services available to a subscriber including flat-rate service and message or measured service are included in the model since the cost of subscribing to a second line may be affected by the choice of services available. Service availability, and price cap information can be found in *NARUC*

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<sup>2</sup> In those areas where flat-rate calling is unavailable, the measured or message rate with 100 five-minute short-distance business-day calls is used.

(1996b). Having a home office may explain why some households have a second line. Education and occupation variables are used to control for having a home office. Household in which either the male-head or female-head have attended college, are employed as a professional or in sales are assumed to be more likely to have a home office. Demographic variables including age, race, children in the household, marital status, unrelated household members, and household size may influence whether a household has a second line.

Subscribing to an on-line service is modeled as a vector of independent variables ( $X_2$ ) that include price, income, exposure to the internet and computers, occupation variables and demographic characteristics. Subscribers had several choices in selecting an on-line service in 1995 including AOL, CompuServe, and Prodigy. Different on-line services vary in price and service options. Households can select among many on-line providers. However, some households will have to pay per call charges to a telephone carrier either because they are on a measured or message local service option or must make a toll call to connect to an on-line service provider. Variables are included into the model that take into account whether a household has a choice to have local service that does not charge per call (flat-rate service) or local service that may charge per call (measured or message service). We have two variables that are used to proxy for the probability that a household has to pay a toll to connect to an on-line service. The first proxy is the distance from the central office serving the sample household and the nearest central office with an AOL or CompuServe access number.<sup>3</sup> The probability of paying a toll for a telephone call increases with the distance between the two central offices. The second proxy is an indicator variable for being in a MSA. Households not in a MSA generally have smaller local calling areas. Households with more exposure to the internet and computers may be more likely to subscribe to an on-line service. Households in which either the male-head or female-head attended college may have used the internet and computers in college. Similarly having a teenager in the household may increase exposure to the internet and computers since many teenagers may

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<sup>3</sup> The source of access numbers was lists provided by AOL and Compuserve to their subscribers in early 1997.

have used the computers and the internet in school. Households in which either the male-head or female-head is employed in professional occupation may have a higher likelihood of learning about the internet at their employment than other households.

### III. The Results

Table 1 presents the estimated coefficients and their standard errors. The results demonstrate the strong connection between subscribing to an on-line service and purchasing an additional telephone line. In addition, the results lend support to the hypothesis that persons more likely to work at home are also more likely to purchase an additional line, even after accounting for the influence of on-line services. It is quite possible that this reflects the convenience of a dedicated business or fax line. The coefficient for the monthly rate for phone service is significantly different from zero and has the expected sign, however, the types of service offerings available appear to have no impact on the decision to purchase a second line. The coefficient for the one-time connection fee is of an unexpected sign, though it is only significant at the 90% level. Several elements could be leading to this result. The connection charges in the data are from 1995, however, we have no information on when the household actually had the additional line installed. Consequently, the connection fee may only be accurate for a fraction of the households in the sample. Furthermore, in many jurisdictions, a portion of the connection fee is an ordering charge. If a household has both of its lines connected at the same time, it only need pay the ordering portion of the connection fee once. Again, the connection fee may not be accurate for some households in the sample. A common perception is that families purchase second telephone lines for their teenage children. While the coefficient is not significantly different from zero, it should be noted that a family with a teenager present is more likely to have a second line than is a family with younger children. Finally, non-white households are significantly more likely to purchase an additional line. This reinforces the findings of the Bureau

of Labor Statistics' Consumer Expenditure Survey that shows that black households spend more on telephone services than do white households.

The results of the on-line services equation point to the importance of familiarity with the new technologies of on-line services and personal computers. The probability of subscribing to an on-line service steadily decreases as the age of the household head increases. In addition, households in which either the male or the female-head attended college are more likely to be familiar with the technology, and therefore are more likely to subscribe to an on-line service. As well, we note that households with a teenager present are more likely to subscribe to an on-line service. This may well reflect the exposure to computers and the internet which is available in some schools. The two elements addressing the cost of accessing an on-line service leave mixed results. The cost associated with a local phone call, as measured by the availability of a flat-rate calling plan, appears to have no effect. However, the distance to the nearest on-line point-of-presence (POP), which is intended to measure the likelihood of being able to access an on-line service with a local phone call, is significant. As expected, the greater the distance to an on-line POP, the less likely a household is to subscribe to an on-line service.

**Table 1**  
**Results of the Bivariate Probit Estimation**

	Second Line Equation		On-Line Services Equation	
	Coefficients	Standard Errors	Coefficients	Standard Errors
Constant	-1.3048**	0.1502	-1.8284**	0.1166
Household (HH) Size	0.1603 **	0.0238	0.0010	0.0267
HH Head's Age < 35	-0.1839**	0.0553	0.1838**	0.0564
HH Head's Age >54	-0.1755**	0.0653	-0.4727**	0.0836
HH Head is Married	-0.1098*	0.0611	-0.1407**	0.0626
HH Head is Divorced	0.2312**	0.0657	-0.1503*	0.0755
HH Head is White	-0.2262**	0.0779	0.1165	0.0936
Unrelated Persons in HH	0.0240	0.0910		
Child < 6 in HH	-0.1724**	0.0665	-0.1575**	0.0746
Child 6-12 in HH	-0.2909**	0.0592	0.0266	0.0669
Child 13-17 in HH	0.0003	0.0638	0.1643 **	0.0737
Professional	0.1260**	0.0476	0.1732**	0.0515
Sales	0.1851**	0.0731	-0.1107	0.0892
Attended College	-0.0438	0.0472	0.3004**	0.0583
HH Income (in \$1,000)	0.0050**	0.0009	0.0049**	0.0009
HH in Non-MSA	-0.0368	0.0557	-0.1020	0.0786
Monthly Tel. Rate	-0.0330**	0.0073		
Tel. Connection Fee	0.0045 *	0.0025		
No Flat-Rate Tel. Service	0.0877	0.0714	-0.0228	0.0772
No Measured Tel. Service	0.1270	0.0859	-0.0279	0.0998
Price Cap Company	-0.0434	0.0417		
HH has On-Line Service	1.1361 **	0.3883		
Miles From On-line POP			-0.0012**	0.0006
RHO	-0.3142	0.1912		
* Significantly different from zero at the 90% level of confidence ** Significantly different from zero at the 95% level of confidence Log Likelihood: -4648 Sample Size: 7664				



Since the estimated equations are non-linear, the coefficients cannot be interpreted as marginal effects. Table 2 provides the marginal effects for some of the variables of interest. The marginal effects are evaluated at the median values for the independent variables. The median household in the sample is a childless married white couple, between 35 and 54 years old, living in an MSA, that have attended college, but are not employed in sales or as professionals, with a household income of \$32,500 per year. The household pays \$13.03 per month for telephone service and \$40 for connection to the network from an RBOC under state price cap regulation which offers both local service options. The household is 19 miles from the nearest on-line POP and does not subscribe to an on-line service. The probability of purchasing a second line is 6.7% for the median household, while the probability of subscribing to an on-line service is 7.9%.<sup>4</sup>

Table 2 clearly illustrates the important role that subscribing to an on-line service plays in the decision to purchase an additional phone line. A household that subscribes to an on-line service is nearly four and a half times more likely to purchase an additional line as one that does not subscribe. The marginal effects also show that teenagers in the household do increase the probability of purchasing a second line, though much of the effect comes through the addition of the additional household member.

The marginal effects also allow us to examine the price and income elasticity of demand for second telephone lines. The demand for second telephone lines appears to be inelastic, though, not surprisingly, it is substantially more elastic than that found for first residential lines.<sup>5</sup> The estimated income elasticities are relatively modest for what once might have been considered a luxury.

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<sup>4</sup> In the sample, 12.0% of households purchase a second line, while 8.4% subscribe to an on-line service.

<sup>5</sup> Estimates of the price elasticity of demand for phone service generally range from 0.01 to 0.1.

**Table 2**  
**Marginal Effects of the Bivariate Probit Estimation**

<b>Deviation from Median</b>	<b>Second Line</b>	<b>On-Line Service</b>
Subscribe to an on-line service	434.8%	----
Toddler Present (HH Size = 3)	-2.3%	-26.1%
Pre-Teen Present (HH Size = 3)	-22.9%	5.3%
Teenager Present (HH Size = 3)	35.0%	34.5%
HH Head is under 35	-31.0%	38.9%
HH Head is over 54	-29.7%	-62.4%
HHers are unrelated (HH Size = 2)	28.6%	----
Single, never married (HH Size = 1)	-9.4%	28.7%
Single, divorced (HH Size = 1)	40.0%	-2.0%
Never Attended College	8.8%	-45.0%
Employed as a professional	26.8%	36.4%
Employed in Sales	41.1%	-19.1%
Not white	51.7%	-20.0%
10% higher income	3.2%	3.0%
HH in Non-MSA	-6.9%	-17.7%
10% increase in monthly phone rate	-8.0%	----
10% increase in phone connection fee	3.5%	----
50 additional miles from On-Line POP	---	-10.7%

### III. Implications of the Results

The strong tie between the decision to purchase an additional telephone line and subscribe to an on-line service provides firm evidence of increasing consumer demand for bandwidth. As

new communications products, such as fax machines, home monitoring systems, and on-line information services, have evolved over the past several years, consumers have been less willing to accept the limits of narrowband communications. In response, we have seen consumers purchase additional channels of the current narrowband service, telephony. This has implications for the introduction of broadband transmission technologies and competition into the local exchange market.

In the short-term, the close link between this fast growing segment of the residential telephone market and the even faster growing market for on-line services may offer opportunities for competitive local exchange carriers to compete for new customers on an equal footing with incumbent local exchange carriers. Several of the most likely entrants into the local exchange market, such as MCI, Sprint, and WorldCom/MFS, are owners of internet backbone facilities. As such, they and the internet service providers they serve may be able to exploit joint marketing opportunities. The growing market for on-line services may also stimulate these companies to enter residential markets as facilities-based providers of both telephony and internet access.

Over the longer-term, it appears clear that many consumers are unwilling to accept the dedicated and exclusive uses that narrowband telephony imposes on them. As new products requiring additional "dedicated" access to assorted networks are introduced, the incentives for the introduction of a single broadband channel into the home is certain to grow. Whether that pipe is the existing phone network using digital subscriber loop technology, the existing cable plant, or some as yet un-envisioned wired or wireless technology, the increasing reliance on network connections will push the technology forward.

## References

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